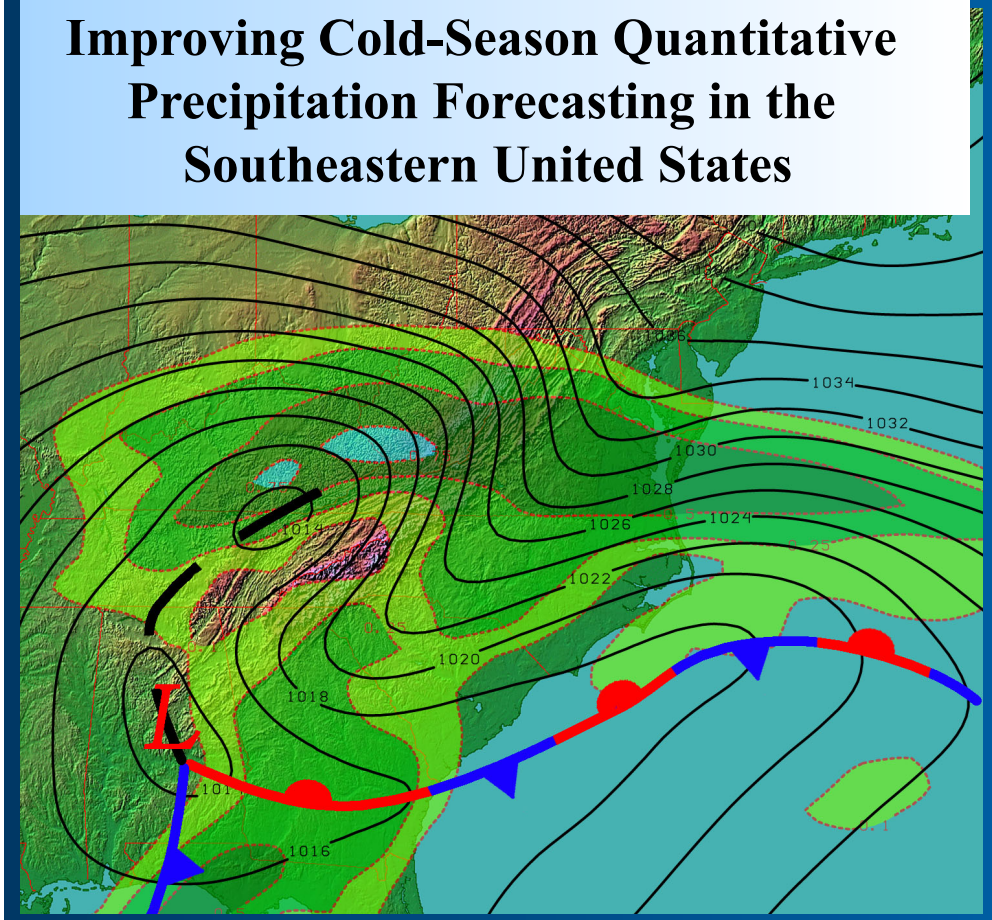
# Improving Cold-Season Quantitative Precipitation Forecasting in the Southeastern United States



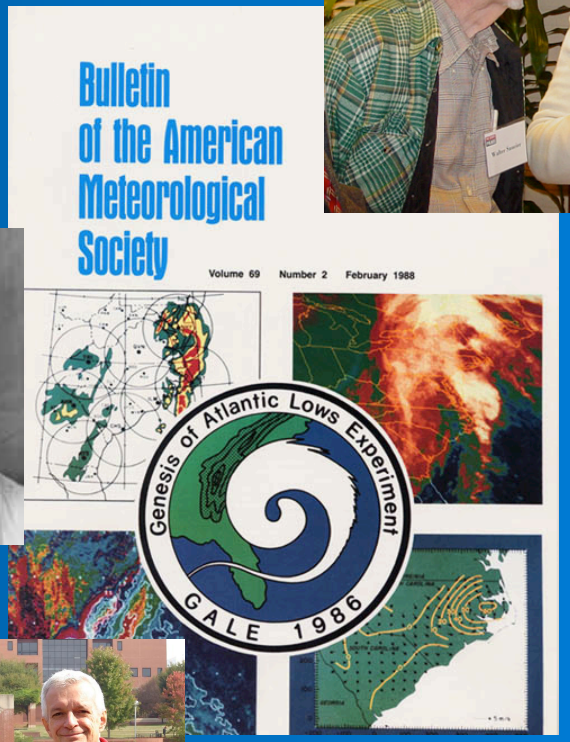

NC STATE UNIVERSITY

## Collaborative History and Upcoming CSTAR Project

Jonathan Blaes (NWS)
Gary Lackmann (NCSU)

# NWS-NCSU Collaborations: History

- 1970s:
  - J. McClain (NWS), W. Saucier (NCSU)
  - Forecast aids: winter precipitation type, flash flood study
- 1980s:
  - The GALE Project
- 1990s:
  - Joint Severe Weather Collaboration
  - Coastal flood model
  - Winter precipitation-type algorithm



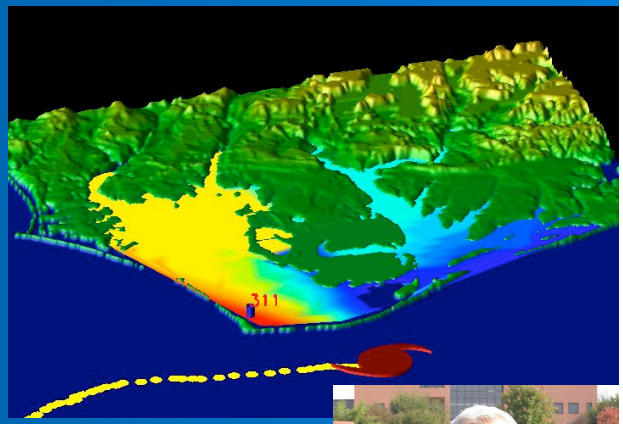

Severe Thunderstorm and Tornado Warnings at Raleigh, North Carolina

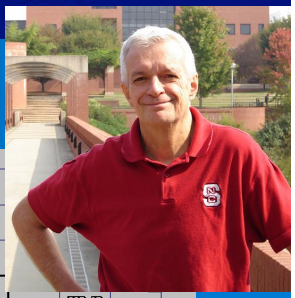
Debra K. Hoium,* Allen J. Riordan,* John Monahan,+ and Kermit K. Keeter#

http://www.erh.noaa.gov/rah/science/science.history.php

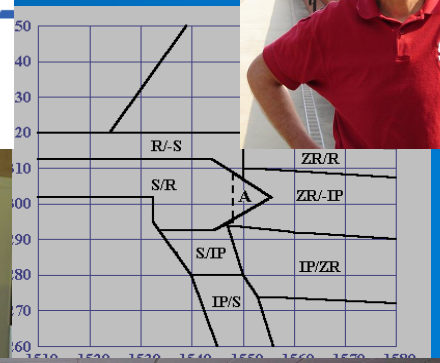
# NWS-NCSU Collaborations: History

- 2000s:
  - CSTAR projects: CAD, surge, TC-Tor
  - Intern course (spring offering)
  - Regional collaborations
  - Open houses, site visits, GoTo Meeting










http://www.erh.noaa.gov/rah/science/science.history.php

# O2R2O

**Planning: Survey Operational Forecasters (O2R)**

- What are their most challenging forecast scenarios?
- Where do they feel research can benefit operations?
- Communication – what new capabilities do researchers bring?

**Development: Formulate hypotheses, science questions**

**Involvement: Collaborative interactions during research**

**THEN…. R2O, if warranted:**

Level 1 - Discover & Share (Only the Beginning)

Level 2 - Demonstrate added value (So What? Show Me!)

Level 3 - Operational Implementation (Practical?)

Level 4 - Mastery (By all, not a few)

Level 5 - Periodical review (A Necessity)

# Upcoming CSTAR Project at NCSU

Focus: **Inland impacts of tropical cyclones**

- Flooding/rainfall distribution
- Inland wind prediction
- 9 of 10 regional NWSFO: Research/operations priority

Collaborative partners:

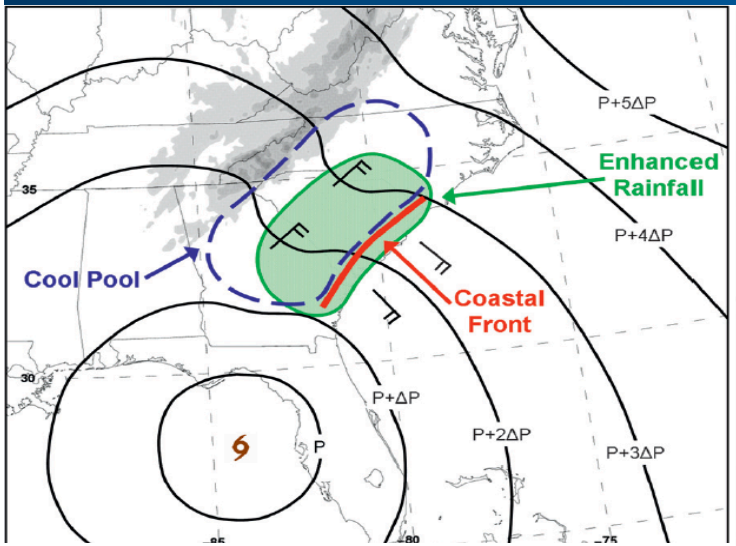
National Centers (TPC, HPC, SPC)
Regional NWSFO (10 offices)
RENCI (real-time NWP testbed system in 3rd year)
Opportunity to work closely with HMT-SE
PIs: Lackmann, Aiyyer, Etherton (RENCI), Parker

HMT-SE wish list: Enhanced observations of landfalling TC?

# Inland TC Impacts & Challenges

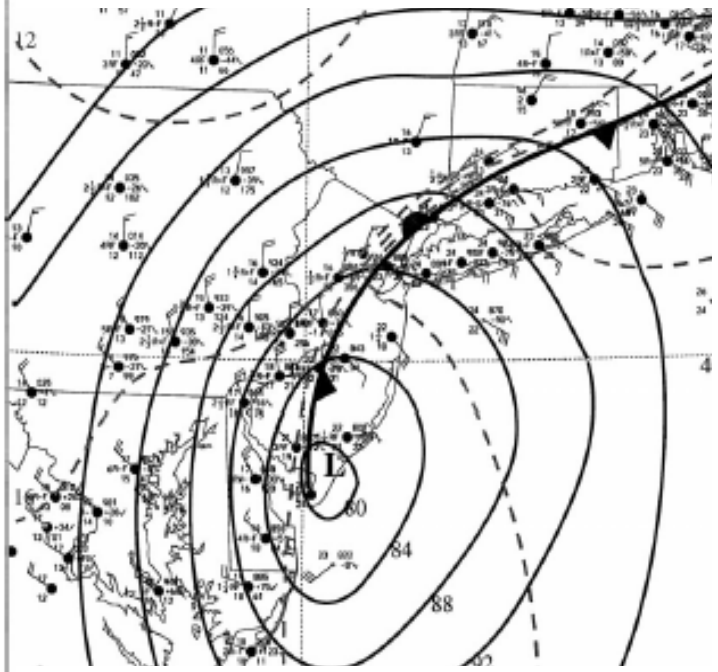
**Boundaries** can affect inland TC rainfall distribution:

- Predecessor Rain Events (PREs – Cote 2007, SUNY)
- Cold-air damming (CAD) and coastal-front interaction
- Also: Marked influence on surface wind field
- TC operational initial conditions problematic




Srock and Bosart (2009)

2100 UTC 16 Sep 1999



Colle (2003) - Floyd

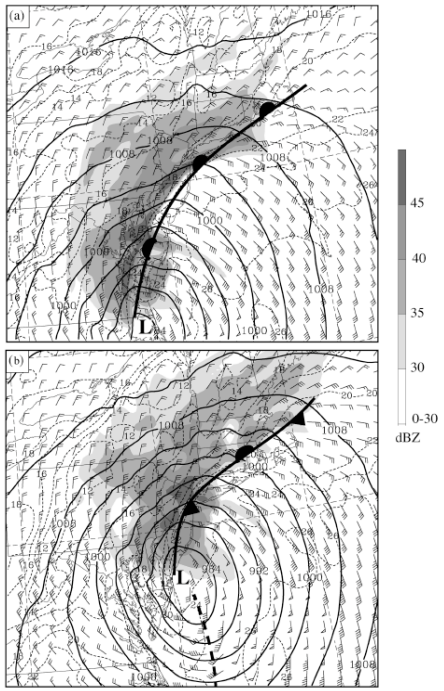
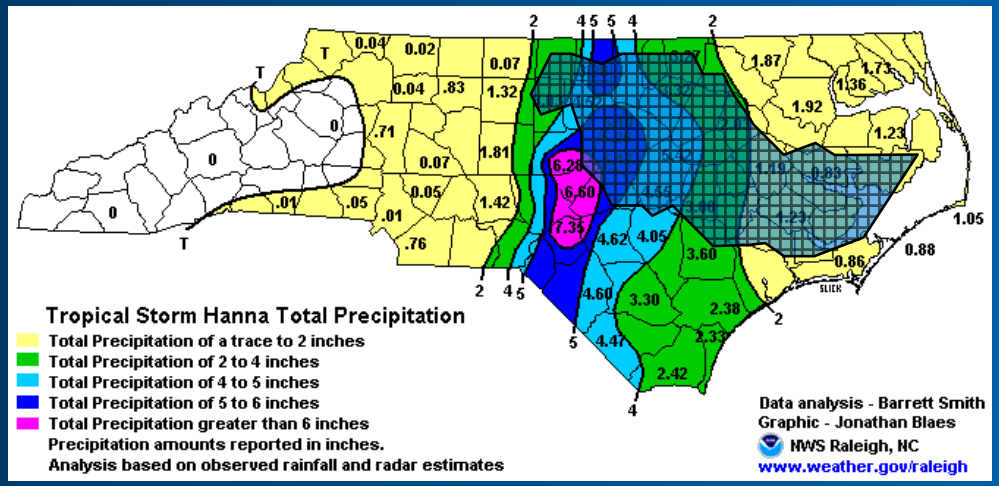
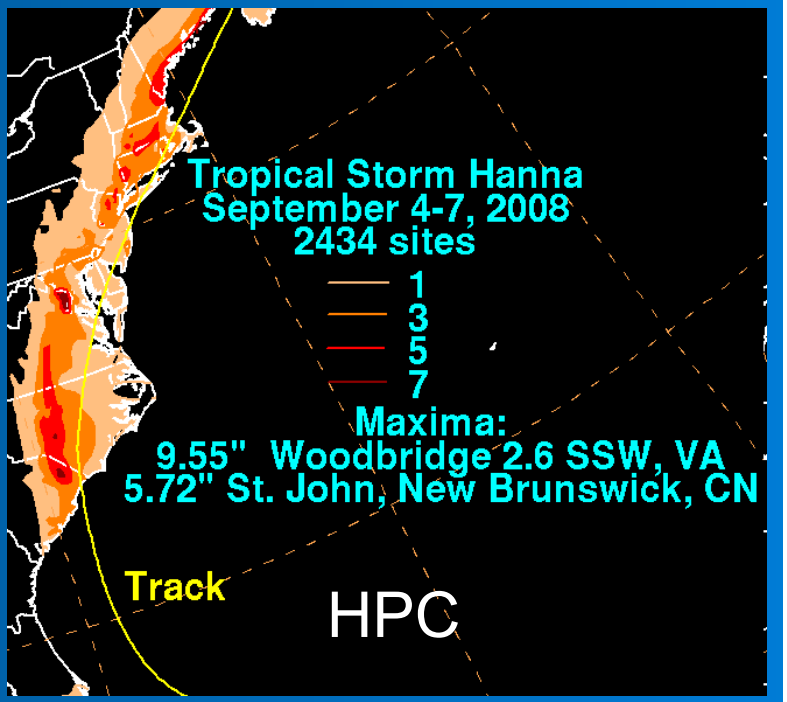
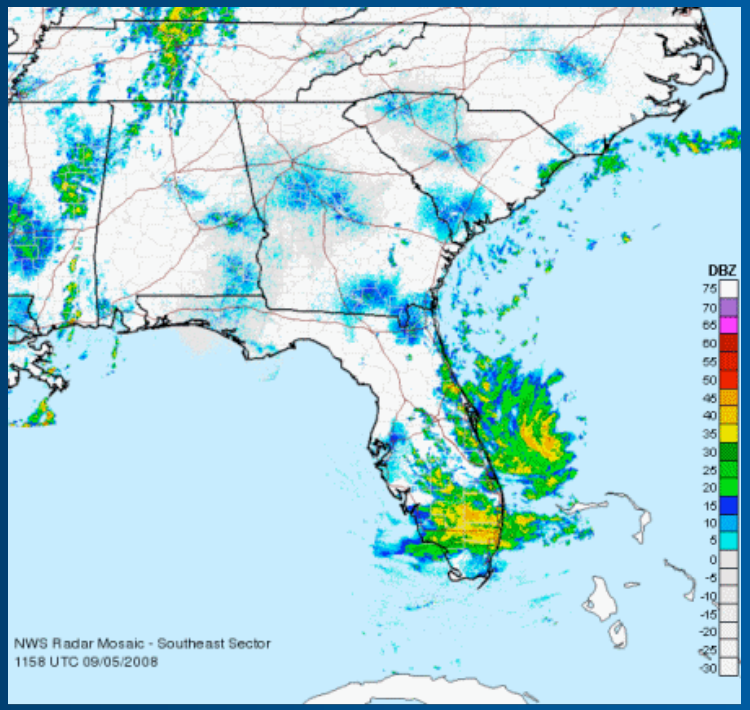


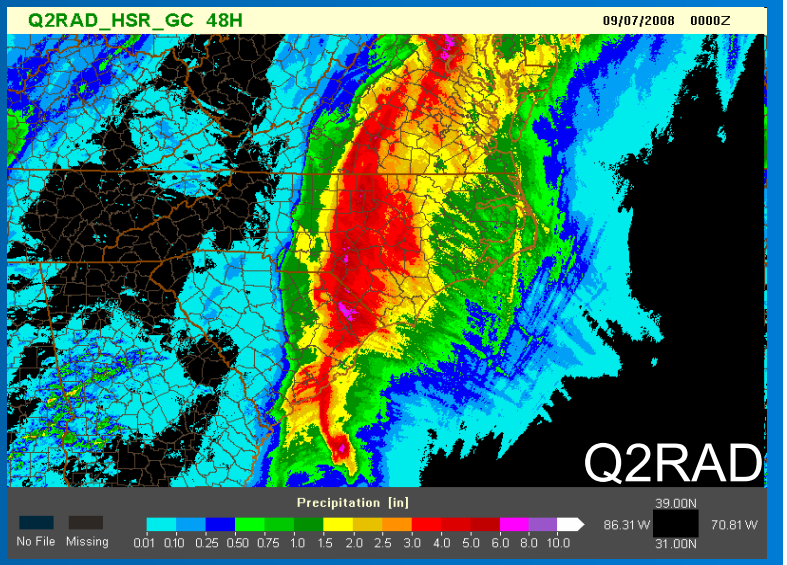

FIG. 11. Model surface prediction for the 12-km domain at (a) 1500 UTC (15 h) and (b) 2100 UTC (21 h) 16 Sep 1999 showing sea level pressure (solid) every 4 mb, surface temperatures (dashed) every 2°C, surface wind barbs (full barb = 10 kt), and model reflectivities (shaded) every 5 dBZ.

# Hanna (2008) Example

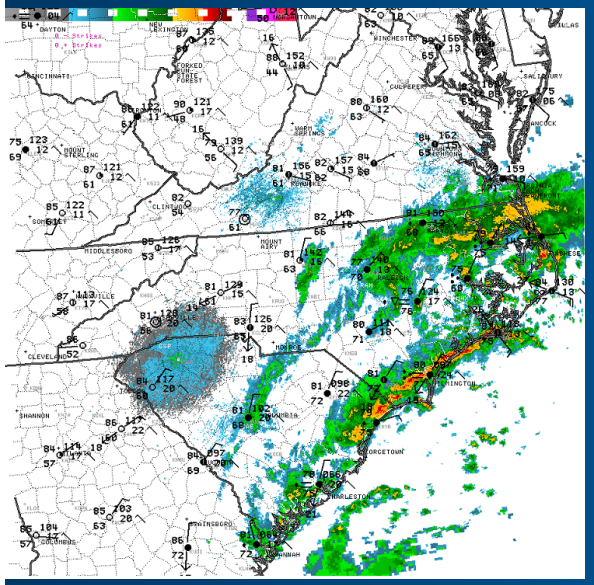


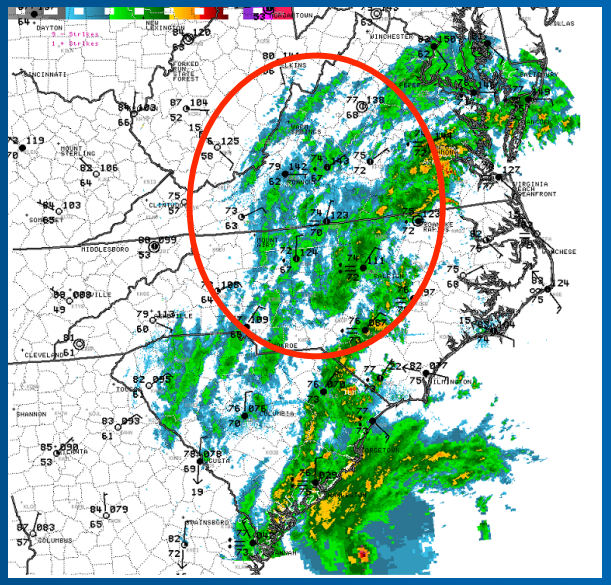



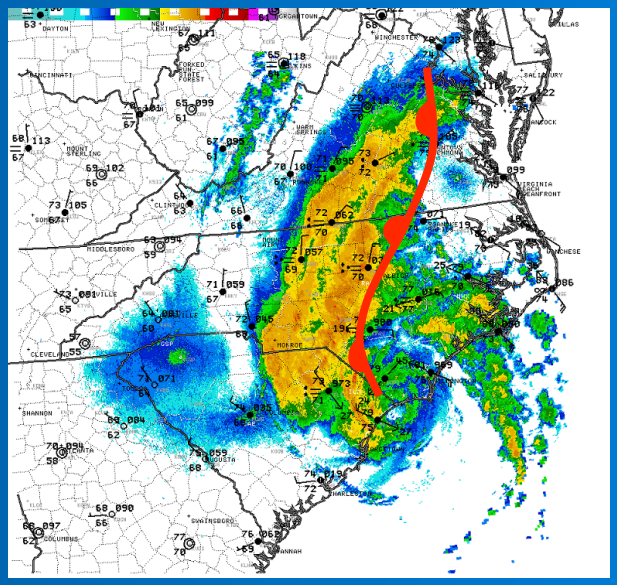



# Hanna (2008) Example







Rain ahead of Hanna: Evaporational cooling, boundary forms

Weak cold-air damming develops, enhanced thermal gradient

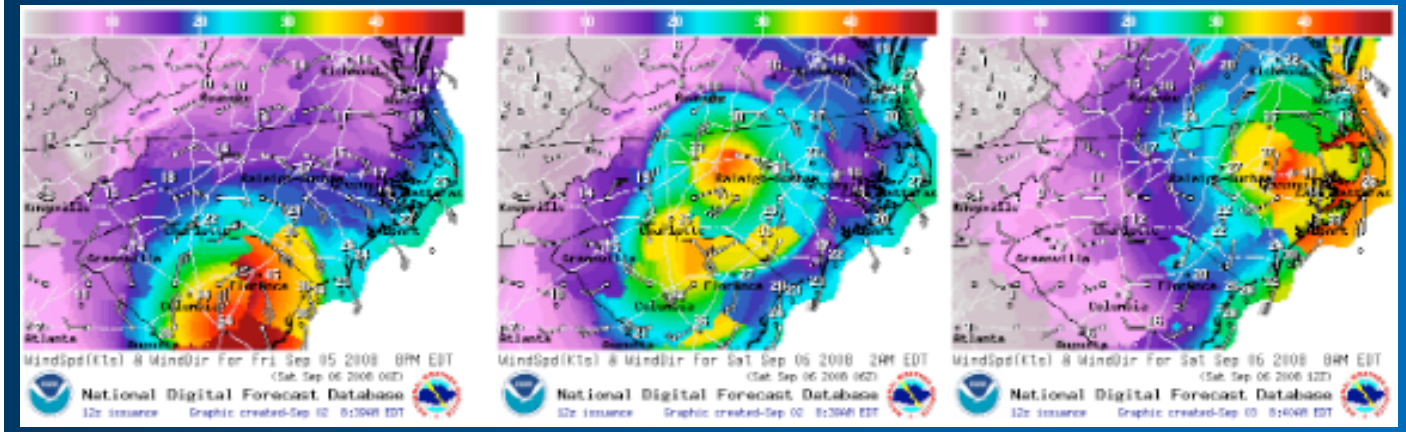
Boundary aids isentropic ascent to west

Stronger winds east of boundary in unstable air, weaker west

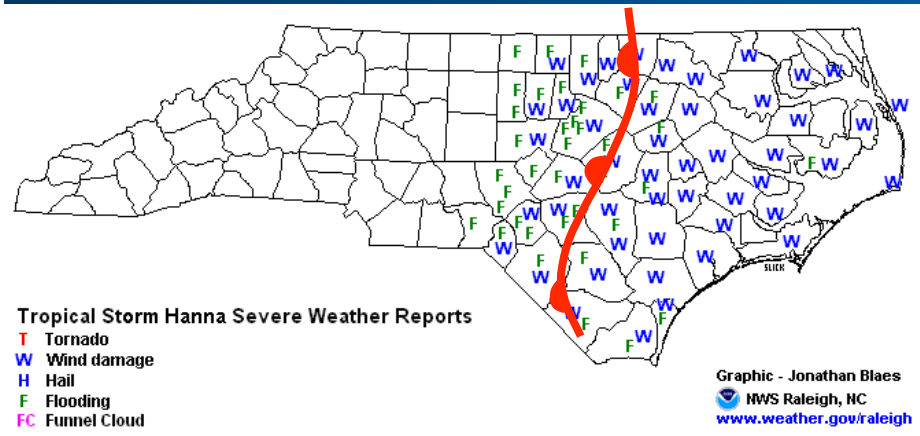
# Hanna (2008) Example

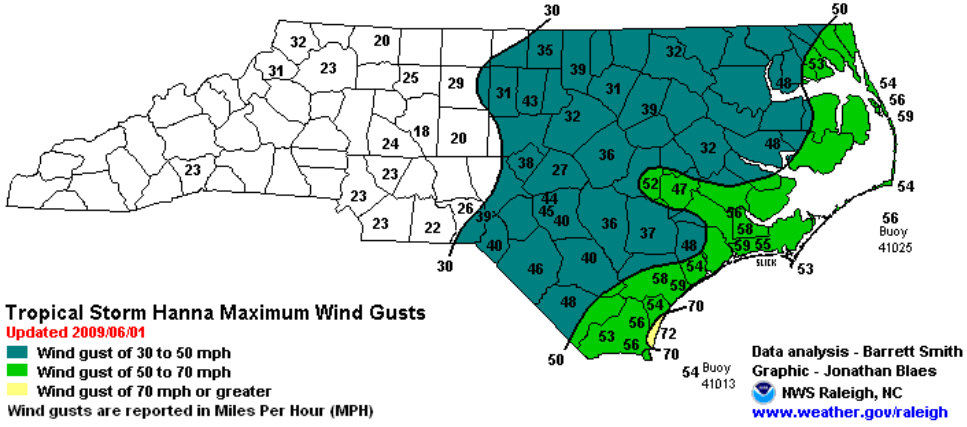
## Challenge of inland wind prediction for the NDFD

- need more science in a difficult operational framework




NDFD wind forecasts for Hanna valid (a) 00 UTC, (b) 06 UTC, 12 UTC Sept 6, 2008




Verifying severe weather reports and wind analyses based on spotter reports and other available data: Boundary location not coincidental

# Science Questions: Landfalling TC Impacts

Mechanisms of formation for boundaries?

- Evaporational cooling, solar sheltering critical
- Terrain, cold-air damming?
- Role of PRE in establishing boundary?

Predictability of boundary formation?

- Difficult NWP representation of diabatic, cloud-radiation
- Representation of PBL, moist processes in NWP?

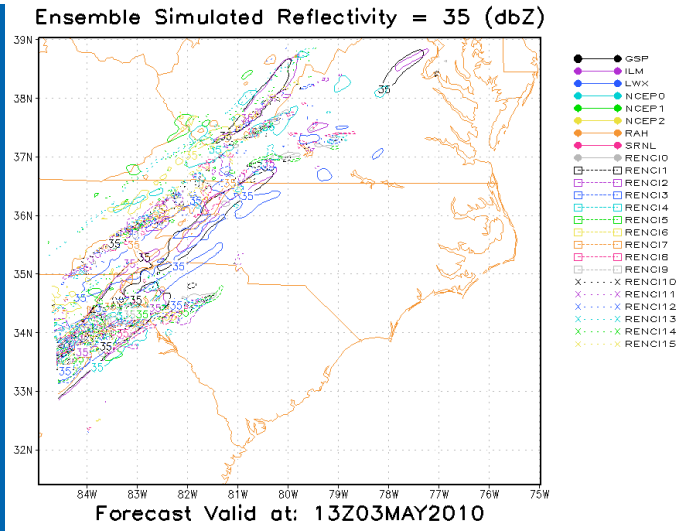
Even with correct boundary: QPF, wind forecasts?

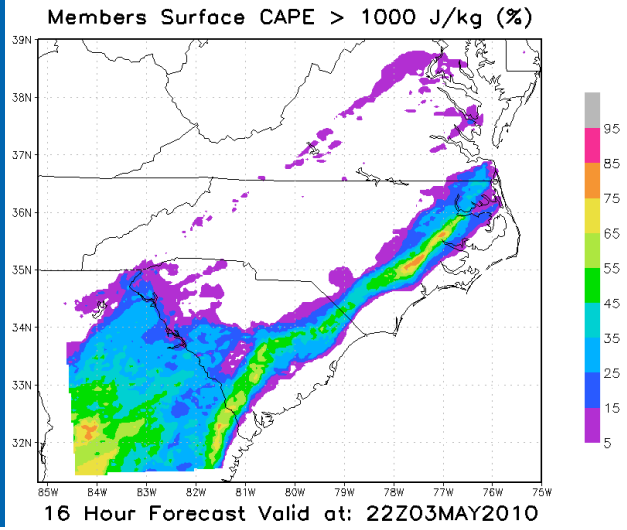
- Importance of boundary to total precipitation?
- Strength of influence on stability, surface winds?

# High Resolution Mid-Atlantic Forecast Ensemble (H-MEF)

http://www.sensordatabus.org/wrf/Pages/WRFImagesAndLoops.aspx

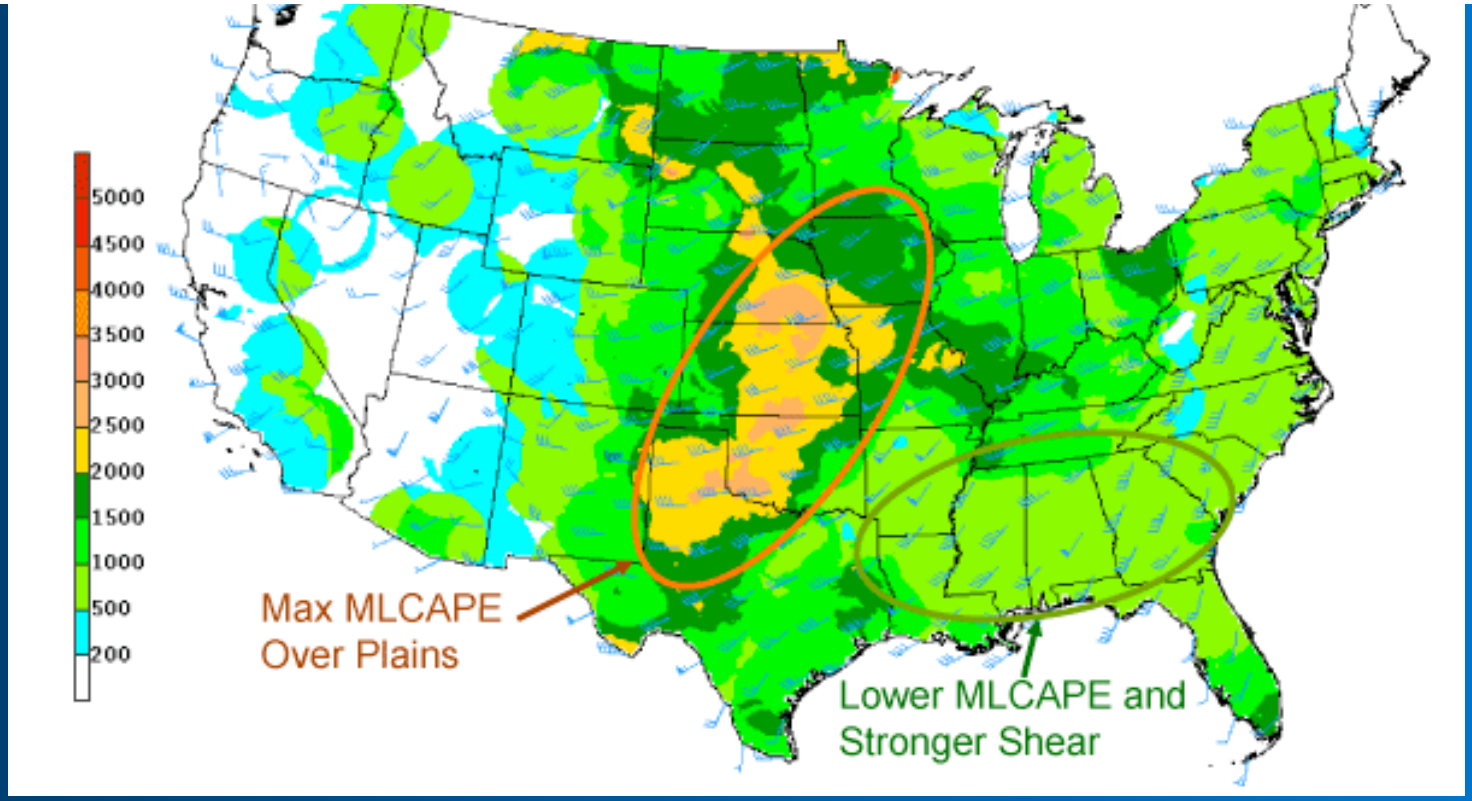
- Leveraging available resources
- Total members = 28
  - CAE - GSP - ILM - LWX
  - MHX - RAH - RNK - NSSL
  - NCEP(3) - SRNL - RENCI (16)
- Forecasts collected 12Z, 00Z
- Out to 24 hours lead time
- Output:
  - **on ftp site**
  - **ingest for AWIPS2**
  - **Images on website**



# Low-Cape, High Shear (LCHS) Events (M. Parker)

ML CAPE (J/kg Shaded), 0-4km shear (kt, barbs), 2004-2005: all tornado reports




HMT-SE support opportunity:

- More surface, upper air observations, radar
- High quality regional analysis (e.g., EnKF)

# Collaborative Experiences and Opportunities

## CSTAR lessons learned

- Collaborative research improves warning performance
- Culture needs to be developed and sustained
- Proximity and contact is very important
- Opportunity to develop an identify future talent

## HMT-SE Opportunities

- Numerous excited collaborative partners: academic (incl. students), operational, governmental, & public sector
- Results relevant to large geographical region
- Infrastructure & resources are preexisting

## HMT-SE Challenges

- Lots of priorities that need to be balanced
- Multi year study should capture some events – hopefully!

# Acknowledgements

NOAA CSTAR program, Sam Contorno, and USWRP, HMT-SE for support and invitation to be here this week (Tim Schneider, Marty Ralph)

Regional CSTAR NWS offices (RAH, GSP, ILM, MHX, CAE, CHS, FFC, RNK, LWX, AKQ)

National Center Partners:  Dave Novak (SPC), Mike Brennan (TPC), Steve Weiss (SPC)

National Weather Service Eastern Region Headquarters – Jeff Waldstreicher

Barrett Smith (NWSFO RAH) for Hanna materials

NWSFO RAH Case Summary Archive: http://www4.ncsu.edu/~nwsfo/storage/cases/20080906/